

Cricopharyngeal Myotomy for Pharyngo-Esophageal Diverticulum

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PROTRUSION of the pharyngeal mucosa posteriorly between the oblique fibers of the inferior constrictor muscle of the pharynx and the transverse fibers of the cricopharyngeus muscle is known as a pharyngo-esophageal diverticulum. First described by Ludlow²⁴ in 1769, it has been well-known as an acquired entity for many years. Today, with the increased longevity of the population, this condition is being encountered more commonly than in the past because of its increased incidence with advancing age. The cause of the condition is unknown, but in recent years, attention has been drawn to a possible obstructive role of the cricopharyngeal muscle or pharyngo-esophageal sphincter in the formation of these pouches; thus various disorders have been ascribed to the sphincter, including spasm,^{3, 4, 27, 28} premature contraction,^{1, 25, 26} delayed relaxation,^{9, 10} failure of relaxation (achalasia),^{3-5, 11, 12, 17, 20, 32} and the phenomenon of a "second swallow" against a closed sphincter.³⁵ Nonetheless, the only reported esophageal motility study of patients with this condition failed to identify any abnormality of pharyngo-esophageal sphincteric function.²¹

Treatment is usually indicated because pharyngo-esophageal diverticula give rise to progressively troublesome symptoms of dysphagia, regurgitation, choking, coughing, and occasionally malnutrition, aspiration, pneumonitis, and lung abscess. Discussion in the past has been concerned primarily with the merits and deficiencies of two-stage²² versus single-stage surgical excision,³³ the advantages of the latter having been clearly established by the large experience reported by Clagett and Payne.⁷ More recently, with increasing emphasis on the possible obstructive role of the pharyngo-esophageal sphincter, cricopharyngeal myotomy, with^{10, 31, 34, 35} or without^{4, 6, 11, 15, 26, 32} diverticulectomy, has been advocated and performed with success on some patients. The purpose of this study is to report our experience with this procedure in the management of the patient with symptomatic pharyngo-esophageal diverticulum and to provide physiologic data relative to pharyngo-esophageal sphincteric function in these patients, based on preoperative and postoperative esophageal motility studies.

Case Material

Eighteen patients with pharyngo-esophageal diverticula operated on between March 1966 and January 1969 were involved in this study. There were ten men and eight women, whose ages ranged from 43 to 87

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TABLE 1. *Maximal Pressures and Length of Pharyngo-esophageal Junction Before and After Myotomy in Patients With Pharyngo-esophageal Diverticula*

Case	Before Myotomy		After Myotomy			
			4 to 10 Days		7 to 24 Months	
	Maximal Pressure, cm. H ₂ O	Length, cm.	Maximal Pressure, cm. H ₂ O	Length, cm.	Maximal Pressure, cm. H ₂ O	Length, cm.
1	35	3			16	1.5
2	18	4	10	2		
3	28	3.5	20	3		
4	40	4	12	4	16	2.5
5	34	4	21	3		
6	29	4	22	3	23	4
7*	32	4.5			9	3
8	33	4				
9					20	4
10			19	2.5		
11			11	4		
Means	31.1	3.8	16.5	3.1	17	3.0

* Two postoperative tests obtained: one at 7 months and one at 19 months. The results were identical.

years, with an average age of 74 years. Dysphagia of varied duration was the only symptom in 13 patients; one patient complained of both dysphagia and aspiration pneumonitis, and four patients had predominantly respiratory symptoms with little or no symptoms referable to the esophagus. Esophageal roentgenograms identified pharyngo-esophageal diverticula that varied in size from 1 by 1.5 cm. to 5.5 by 5.5 cm. A prominence in the region of the cricopharyngeal sphincter was noted in three patients. No other roentgenographic abnor-

malities of the esophagus were noted except for a midesophageal traction diverticulum in one patient and an esophageal hiatal hernia in four patients.

Esophageal Motility Studies

Twenty-one observations of the pressures in the pharynx and the esophagus and its sphincters were made on 11 of the 18 patients in this series. It was difficult, sometimes, to pass the pressure-detecting units beyond the diverticulum, and eight of the 12 patients referred to the laboratory be-

TABLE 2. *Characteristics of Pharyngo-esophageal Sphincter in Health and in Patients With Pharyngo-esophageal Diverticula*

State	Normal ¹⁴		Pharyngo-esophageal Diverticulum*	
	Mean	Range	Mean	Range
Resting				
Maximal pressure, cm. H ₂ O	39	20 to 60	31.1	18 to 40
Length, cm.	3.0	2.5 to 4.5	3.8	3.0 to 4.5
Deglutitive				
Duration of relaxation, sec.	<1	0.5 to 1.2	1.2	0.5 to 1.9
Amplitude of relaxation, cm.	-12	-7 to -40	-25	-12 to -33
Sphincteric contraction pressure, cm. H ₂ O	92	40 to 150	54	27 to 72

* Based on findings in eight patients.

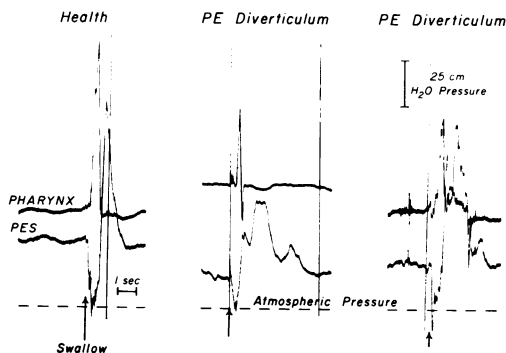


FIG. 1. Deglutition pressures at pharyngo-esophageal junction in a normal person and in two patients with pharyngo-esophageal diverticula. Note that in health (*left panel*) the pharyngo-esophageal sphincter (PES) is open during the entire period of pharyngeal contraction. In the two patients with pharyngo-esophageal diverticula, part or all of the period of pharyngeal contraction occurs after closure of the sphincter (*middle and right panels*).

fore operation had satisfactory records. Observations were made on ten patients after operation, all but three of whom had been studied before operation (Table 1). Intraluminal pressures were obtained via water-filled polyethylene tubes, 5 cm. apart, with side openings and attached to externally placed strain-gauges by technics previously described.⁸ Pressures of the inferior and superior esophageal sphincters, the esophagus, and the pharynx were obtained at rest and with swallowing. Measurements were made of the length of the pharyngo-esophageal sphincter and of its maximal resting pressure. The magnitude of the deglutitory responses in the pharynx and pharyngo-esophageal sphincter and the temporal relationships existing in the two regions were assessed when pressures were being recorded from the two sites simultaneously. The resting-pressure profile of the lower esophageal sphincter and the pressures in the body of the esophagus after deglutition were evaluated to determine if any other abnormalities existed.

An analysis was also made from the records of 21 successive patients studied in

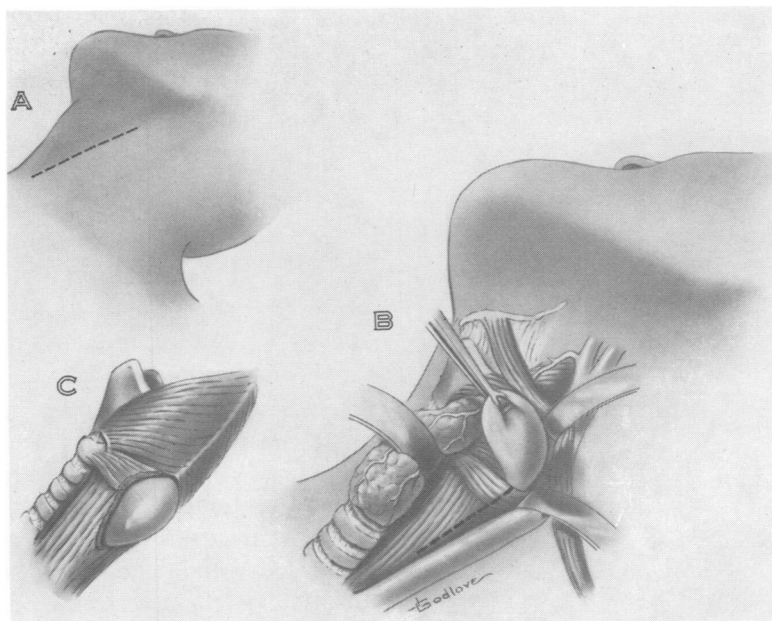
the laboratory for esophageal abnormalities who had a normal pharynx and upper esophagus. The records obtained with two or three pressure detectors in the pharynx and pharyngo-esophageal sphincter were assessed primarily for the temporal relationships existing in the two regions.

Preoperative Findings. A zone of elevated pressure was detected at the pharyngo-esophageal sphincter in all eight patients. The elevated pressure zone was slightly longer, and the maximal pressures within it were slightly lower than those reported from a series of younger normal persons (Table 2). With deglutition, all of the patients studied had immediate sphincteric relaxation followed by contraction (Fig. 1). The magnitude of relaxation was greater and its duration longer than in the previous report,¹⁴ and the amplitude of sphincteric contraction was less.

All of the patients observed before operation had an abnormal temporal relationship between pharyngeal contraction and pharyngo-esophageal sphincteric relaxation and contraction. In these patients, sphincteric contraction (or termination of sphincteric relaxation) occurred prior to completion of the contraction in the pharynx. This abnormality, though present in all patients in the series, did not occur during all swallows. The abnormal sequence occurred in 55% of the swallows, but the abnormality in the patients ranged from 14% (1 of 7 swallows) to 90% (9 of 10 swallows). When the records of the 21 patients without pharyngeal diverticula were assessed, no such abnormality was observed in any of the patients from which 91 observations were obtained.

Pressure abnormalities in the body of the esophagus were present in only one of the eight patients studied preoperatively. The abnormality was that of diffuse spasm. Four patients had pressure indications suggestive of hiatal hernia.

FIG. 2. Technique of esophagomyotomy. A, Site of skin incision. B, Exposure of diverticulum. Dotted line indicates proposed myotomy site. C, Completed operation.



Surgical Technic

Cricopharyngeal myotomy was performed in all 18 patients, being combined with diverticulectomy in four, by a technic previously described.²⁹ In four other patients with relatively large diverticula in whom the diverticulum was not excised, suture suspension of the pouch superiorly to the prevertebral fascia was carried out. The technic of esophagomyotomy is illustrated in Figure 2. Access to the diseased region is obtained through a left oblique cervical incision bordering the anterior edge of the sternocleidomastoid muscle. The pharyngo-esophageal region is exposed by retraction of the carotid sheath laterally and the trachea and larynx anteriorly and to the right. After the diverticulum is freed to its neck, the transverse fibers of the cricopharyngeal muscle bordering the inferior margin of the neck of the diverticulum are easily identified and incised. In six of the 18 patients, hypertrophy of the cricopharyngeal muscle was noted at operation. Biopsy in three instances revealed significant fibrosis. The incision is carried down to the mucosa

and is extended caudally on to the esophagus, the length of the incision averaging about 3 cm. After the myotomy, the esophageal and cricopharyngeal muscles are dissected from the underlying mucosa for about half the circumference of the mucosal tube to allow the mucosa to protrude freely through the incision. The cervical wound is then closed with interrupted sutures, with or without drainage. The patient is allowed free oral feedings and is discharged from the hospital a few days subsequently.

Results

Surgical complications did not occur in any of the 18 patients, and all of them could eat without dysphagia when dismissed. Although the follow-up period has been brief, averaging 17 months, all have had subsequent clinical reevaluation either at the Mayo Clinic (eight patients) or by letter from the patient or his referring doctor (ten patients). Complete relief of pre-operative symptoms was experienced by 13 of the 18 patients. Five patients who had

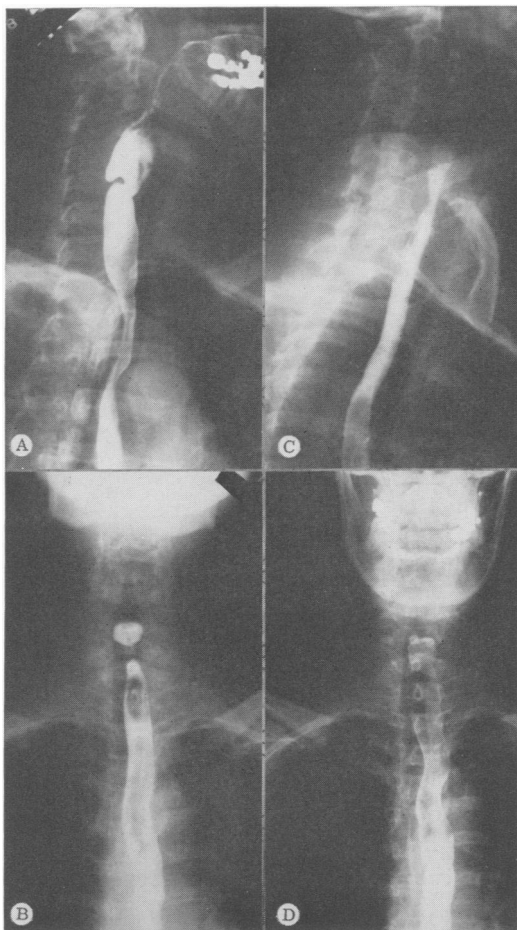


FIG. 3. Esophageal roentgenograms in patient with small pharyngo-esophageal diverticulum. A and B, Before operation. C and D, Five days after esophagomyotomy.

myotomy alone, the four who had myotomy and diverticulopexy, as well as the four who also had diverticulectomy, were asymptomatic. Four with myotomy alone had only occasional symptoms, while the other myotomy patient still had considerable difficulty in swallowing.

Postoperative Roentgenography. Twenty-eight postoperative roentgenoscopic examinations were made on 16 of the 18 patients. Nine of the studies were done prior to dismissal, from 5 to 13 days after operation. In all instances, the diverticulum either was no longer identifiable (Figs. 3, 4, and 5) or was considerably

smaller than before operation. Subsequent roentgenoscopic examinations, sometimes on multiple occasions, were made up to 36 months later in 14 patients, and in all but 1 patient, a diverticulum could not be identified (Fig. 5). Eleven of the 14 patients, including the patient with a persistent diverticulum, had not had diverticulectomy (Fig. 6). The diverticulum in this one patient was the largest of the group, measuring 5.5 by 5.5 cm.

Postoperative Esophageal Motility. Thirteen studies were carried out on 10 of the patients after operation (Table 1). Seven studies were done within 10 days of operation and the other six at a later time, up to 24 months after operation. The early and late findings were identical, being characterized by a reduction of 50% in the resting pressures at the pharyngo-esophageal sphincter and a decrease in its length (Table 1 and Fig. 7). With deglutition, relaxation and contraction persisted, but the magnitude of each component was reduced (Fig. 8). The abnormal temporal relationship that existed between pharynx and sphincter before operation was also present in all patients observed after operation.

Comment

The concept of purposely weakening the pharyngo-esophageal sphincter in the management of patients with pharyngo-esophageal diverticula is not a new one. Negus^{27, 28} advocated peroral dilation of the sphincter, whereas Dohlman and Mattsson,¹³ among others,^{15, 16, 20, 23} have used endoscopic diathermy division of the septum or common wall between the esophagus and the diverticulum. The procedure of cricopharyngeal myotomy was the natural consequence of the introduction by Asherson² in 1950 of the term "achalasia" as applied to various neuromuscular disorders affecting the cricopharyngeal muscle. Subsequently, a number of reports appeared in the literature

describing the successful use of this operative procedure in various conditions including bulbar poliomyelitis,^{18, 19, 25} progressive muscular dystrophy,^{8, 30} and brainstem damage.^{8, 34}

Sutherland³² revived the term "cricopharyngeal achalasia" in 1962, and implicated this mechanism in the development of pharyngo-esophageal diverticulum. He performed cricopharyngeal myotomy on eight patients with so-called achalasia, three of whom had pharyngeal pouches. A few years before, Harrison¹⁵ had employed the technic, combined with inversion of the diverticulum, in three patients. Subsequently, Davis and associates¹¹ and Blakeley and associates⁶ each reported two patients with pharyngo-esophageal diverticula who were treated successfully by cricopharyngeal myotomy. The most extensive experience with this technic is that of Belsey⁴ who, in 1966, reported its use in 32 patients with pharyngo-esophageal diverticula, most of whom had diverticulectomy performed at the same time. He was of the opinion that cricopharyngeal achalasia or spasm is the cause of pharyngo-esophageal diverticulum.

From the present studies, it is clear that our patients with pharyngo-esophageal diverticula did not have "cricopharyngeal achalasia" because the pharyngo-esophageal sphincter relaxed promptly and normally after every recorded swallow. Similarly, there was no "spasm" of the sphincter in these patients because the resting pressures and the length of the pharyngo-esophageal sphincter were within the range of health and sphincteric contractions were not excessive. If anything, the patients with pharyngo-esophageal diverticula had lower sphincteric pressures and a slightly longer zone of elevated pressure. Any differences between the values found in this study and those from the previous report from this laboratory¹⁴ are small and may be due to differences in technic or to the difference in the ages of the two groups studied.

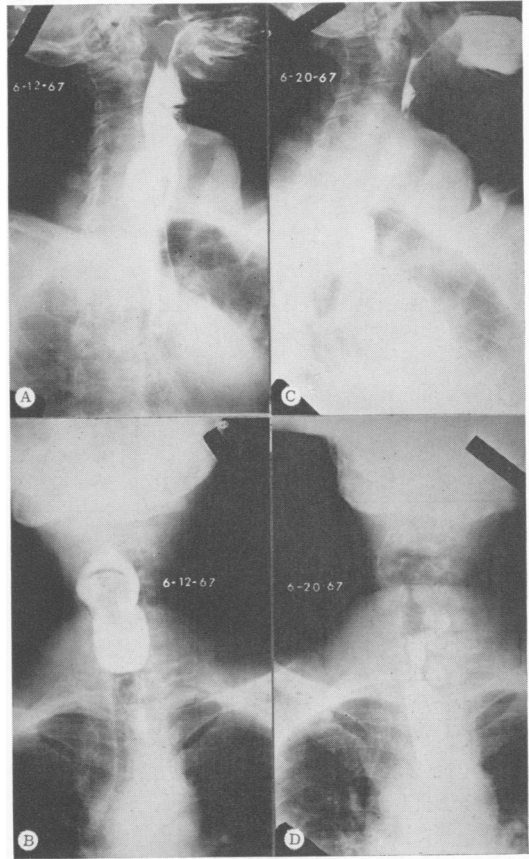


FIG. 4. Esophageal roentgenograms in patient with a moderate-sized pharyngo-esophageal diverticulum. A and B, Before operation. C and D, Five days after myotomy and suture suspension of the diverticulum.

However, the temporal relationship between pharynx and sphincter was often abnormal, and was abnormal in all patients some of the time, but the abnormality was not of failure to relax but of delay in termination of pharyngeal contraction. The defect in timing was small, being a fraction of a second. The normal response in this region displays sphincteric relaxation during the entire period of pharyngeal contraction. This relationship provides an open pathway into the esophagus for swallowed material.

The significance of these findings in such a small number of patients is not clear, but it does suggest that incoordination of the

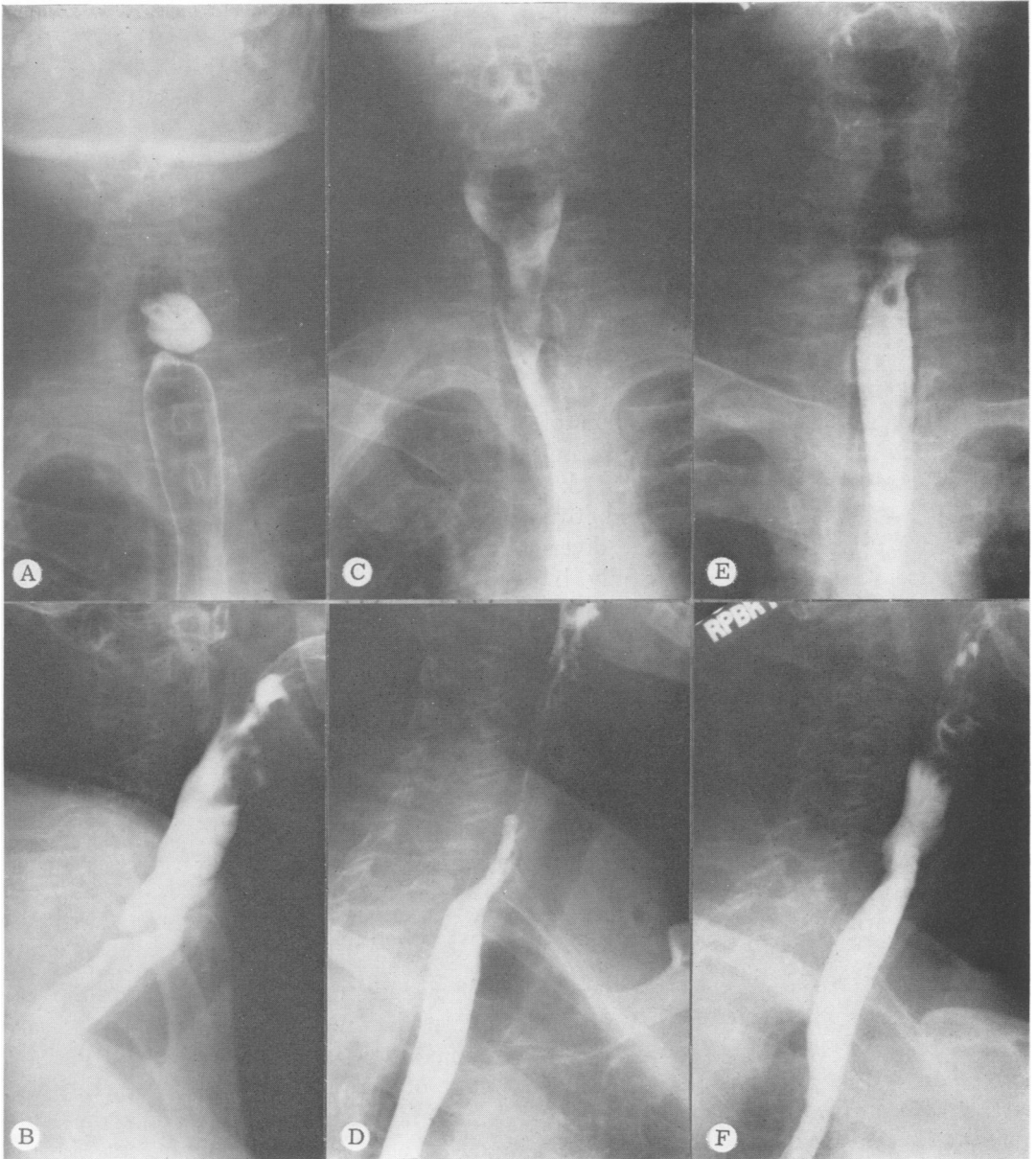


FIG. 5. Esophageal roentgenograms in patient with pharyngo-esophageal diverticulum. A and B, Before operation. C and D, Four days after esophagomyotomy. E and F, Ten months later.

pharyngo-esophageal peristaltic sequence may exist and may result in the pressure of pharyngeal contraction being exerted against a closed sphincter, thereby contributing to the development of a pharyngeal pouch. Myotomy is successful by reducing resting sphincteric pressures by ap-

proximately 50%. This concept, however, does not explain the low recurrence rate after simple diverticulectomy. Although Kodicek and Creamer²¹ found normal motility in five patients with pharyngo-esophageal diverticula, one of their illustrations is consistent with our findings. Further-

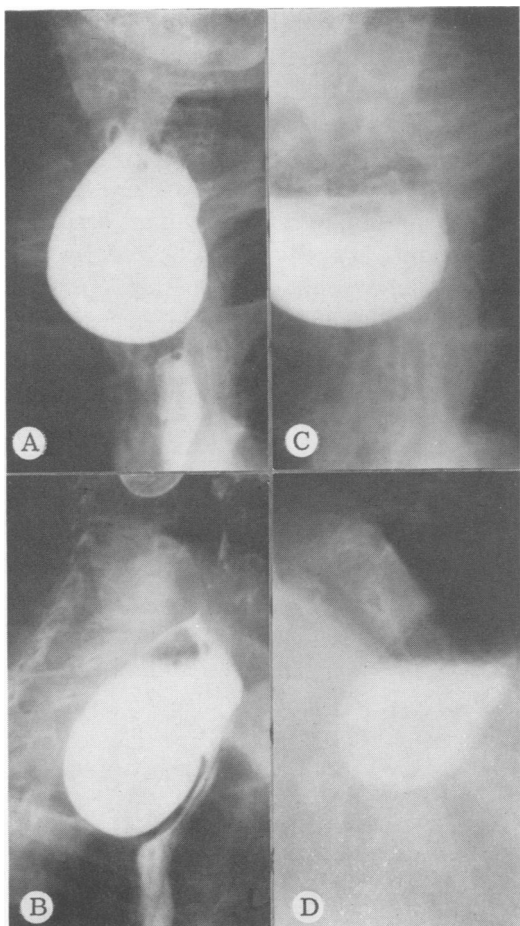


FIG. 6. Esophageal roentgenograms in patient with large pharyngo-esophageal diverticulum. A and B, Before operation. C and D, Fourteen months later.

more, this concept of abnormal function is supported by the careful cineradiographic studies of Lund^{25, 26} and of Ardran and Kemp¹ who have noted "premature contraction" of the pharyngo-esophageal sphincter in such patients.

While this study has, by no means, clearly elucidated the cause of pharyngo-esophageal diverticulum, it has provided useful information concerning the indications for cricopharyngeal myotomy in the treatment of pharyngo-esophageal diverticulum. Of the 18 patients included in this study, 14 were subjected to cricopharyn-

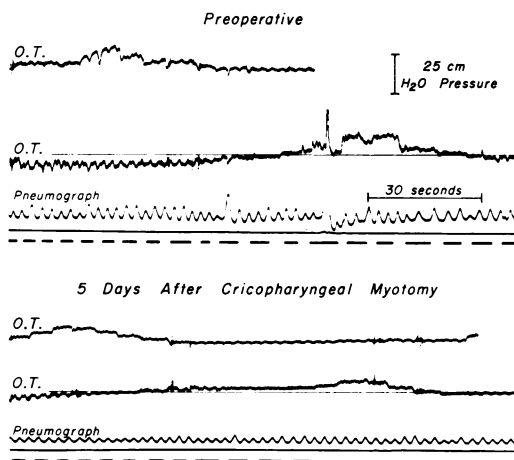


FIG. 7. Resting pressures at the pharyngo-esophageal junction in patient with pharyngo-esophageal diverticulum, before esophagomyotomy (upper panel) and 5 days after surgery (lower panel). Note decrease in sphincteric pressure and shortening of sphincter after operation.

geal myotomy alone or combined with diverticulopexy and only one was not improved by the operation. Nine were asymptomatic, and four had only occasional

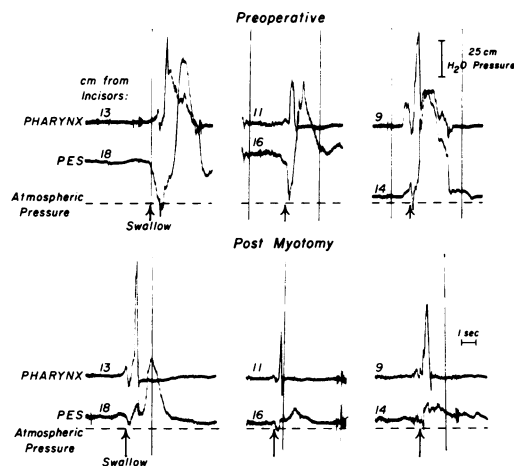


FIG. 8. Deglutition pressures at pharyngo-esophageal junction in patient with pharyngo-esophageal diverticulum before surgery (upper panel) and 5 days after esophagomyotomy (lower panel). Same patient as in Figure 7. Note occurrence of pharyngeal contraction after closure of the pharyngo-esophageal sphincter (PES). This abnormal sequence is not altered by myotomy, but the amplitude of sphincteric contraction is markedly reduced, as is the amplitude of relaxation.

symptoms. Thirteen of these 14 patients had postoperative roentgenoscopy. In nine patients, diverticula were not noted; in three, the diverticula were smaller; in one, the diverticulum was unchanged. The failure occurred in a patient with a large diverticulum. Cricopharyngeal myotomy, therefore, should be restricted to patients with small diverticula, and excision should be advised for large diverticula (5 to 6 cm. or more in diameter). Whether or not concomitant suture suspension of large diverticula to the prevertebral fascia is indicated cannot be answered from this study. The excellent results and low recurrence rate after excision alone can be hardly improved, yet the addition of myotomy to such a procedure, particularly when a prominent cricopharyngeal muscle is noted roentgenoscopically, might reduce to an even lower level the already negligible recurrence rate. The simplicity and safety of cricopharyngeal myotomy would seem to favor it over excision as an alternative procedure for the management of small-to-moderate esophageal diverticula.

Summary

Eighteen patients with pharyngo-esophageal diverticula were treated by cricopharyngeal myotomy. In addition to the myotomy, four had diverticulopexy and four had diverticulectomy. All but one of the 18 patients were improved by the operation. Fourteen were asymptomatic and three had only occasional symptoms of dysphagia. Of the 14 patients treated by myotomy without diverticulectomy, one patient with a large pouch was not improved. A persistent diverticulum was visible roentgenoscopically in this patient after operation, whereas it had disappeared or regressed markedly in size in the 15 other patients studied after operation.

Esophageal motility studies done before operation in eight of the 18 patients showed

no significant abnormalities in pharyngo-esophageal sphincteric pressure or length, incidence and duration of relaxation, or magnitude of contraction. However, an abnormal temporal relationship between swallowing responses in the pharynx and sphincter was noted intermittently in all patients; the abnormality was characterized by the occurrence of sphincteric contraction prior to completion of pharyngeal contraction. This abnormal sequence was not altered by cricopharyngeal myotomy, but the operation reduced the resting pressures in the sphincter by 50% and produced a modest decrease in its length.

Cricopharyngeal myotomy is proposed as a simple, safe, and successful alternative to diverticulectomy for the symptomatic patient with a small or moderate-sized pharyngo-esophageal diverticulum. Patients with diverticula of large size (5 to 6 cm. in diameter) should have diverticulectomy.

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